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Contributions of natural sources to ozone and PM concentrations

Azimeh Zare (1), Jesper Christensen (1), Allan Gross (2), parviz Irannejad (3), Marianne Glasius (4), and Jørgen Brandt (1)

(1) Department of Environmental science, Aarhus University, Roskilde, Denmark (aza@dmu.dk), (2) AU Herning, Aarhus University, Herning, Denmark, (3) Institute of Geophysics, University of Tehran, Tehran, Iran, (4) Department of Chemistry and iNANO, Aarhus University, Aarhus, Denmark

Natural emissions play an important role in determining ambient levels of harmful atmospheric pollutants, especially tropospheric ozone and particulate matter (PM). Natural sources have become more important with the ongoing reductions of anthropogenic emissions and are expected to be even more significant in the future in connection with a changing climate. Despite of the efforts made for modelling of natural emissions, the uncertainties and gaps with regard to investigation and quantification of these emissions are still quite large.
In this study, the large-scale atmospheric chemistry transport model, DEHM (the Danish Eulerian Hemispheric Model) is further developed, evaluated and applied to study and quantify the contributions of many compounds from the natural sources to the concentration of ozone and formation of PM. The relative contributions are calculated for the domain covering more than the Northern Hemisphere for a typical year 2006.
Natural source categories adopted in the recent model consist of vegetation, lightning, soils, wild animals and oceans. Here, DEHM has been further developed to include more natural emissions of biogenic volatile organic compounds (VOCs) as well as a scheme for describing secondary organic aerosols. Moreover, the parameterization used for estimating sea-salt generation has been modified to contain additional features. Evaluation of the modeled total fine PM, against observations, is conducted for both the previous and new model versions to assess improvement of the model performance with the updated description of natural emissions.
Using the developed DEHM, our simulations indicate that at the Northern Hemisphere the contribution from natural emissions to the average annual ozone concentrations over land is between 4-30 ppbV. Among the natural emissions, biogenic VOCs are found to be the most significant contributors to ozone formation. Our results show that biogenic VOCs enhance the average ozone concentration with around 11% over land areas of the Northern Hemisphere.
Similarly, the highest contribution of all the natural sources to total fine particles over land is observed in South America by about 74% and sea-salt aerosols found to play the most important role. However, over the rest of regions in the model domain the largest contribution from the natural sources to PM2.5 is due to wildfires. The contribution from natural emissions to the mean PM2.5 concentration over the land areas in the model domain is about 34%.